Appendix G

Dock Assessment by Reid Middleton

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Engineers
Planners
Surveyors

Ron Summers, General Manager
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Subject: Maury Island/Northwest Aggregates - Preliminary Inspection Findings and Proposed Repair and Maintenance

Dear Ron,

A preliminary engineering evaluation of the Barge Loading Facility at Maury Island was performed at your request. We understand we are to specifically address several key questions raised by King County in connection with preparation of the Final Environmental Impact Statement (FEIS). For purposes of preparing this evaluation and answering these questions, we performed two site visits to visually examine the existing structure and its components. The first site visit was performed on January 14, 2000, by another Reid Middleton structural engineer and me in conjunction with a representative from General Construction Company to inspect the trestle, walkways, pier, and support piling. A subsequent site visit was performed on February 15, 2000, by three structural engineers from our firm to perform additional pier inspection, documentation, and evaluation of the trestle, pier, walkways, abutment, support piling, and mooring dolphins. The opinions expressed in this letter report are a result of these field inspections and our experience with evaluation and design of similar facilities throughout Puget Sound.

Background

We understand that Northwest Aggregates is interested in performing maintenance and repair to the existing barge loading trestle, pier, and mooring system to resume aggregate loading operations at their Maury Island quarry. The facility was constructed in 1968.

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Field Observations and Description

The following review and recommendations are based on site visits made on January 14 and February 15, 2000. The site visits included visual observation only and did not include extensive exploratory work, underwater inspection, or any materials testing. More thorough exploratory work and material testing is anticipated to be performed prior to a detailed engineering report and subsequent final design.

The existing load-out conveyor is oriented east/west with the load-out tower located at the east end. The existing conveyor support consists of 13 bents spaced at approximately 19'-3" on center and extending approximately 250 feet from bent 1 at the face of the bank to the west bent (14) of the load-out tower. Support spacing within the bents averages 7'-6". The conveyor slope is approximately 7 vertically to 100 horizontally. The load-out tower is 8'-3" north/south by 9'-3" east/west with column-supported extensions at the north (for the conveyor drive motor) and south sides.

The existing conveyor support structure is heavy timber and wood-framed constructed with double pile bents, 12x12 caps, and 4x8 bracing. Timber pile bents extend up to heavy timber caps located at the underside of the sloping conveyor truss with double 4x8 stringers at the lower walkway except at the two bents (12 and 13) adjacent to the conveyor take-up. At these two bents, the heavy timber pile caps are located at the lower walkway level and 10x10 columns extend from these caps up to heavy timber caps supporting the conveyor truss. Support bents are interconnected at the lower walkway level by 4x12 struts (parallel to the conveyor). Bracing consists of x-bracing within the bents except at bents 1 and 2 and between every other pair of bents starting at bent 4 (4-5, 6-7, 8-9, 10-11, and 12-13). Bracing is not interconnected at the cross. Strut, double stringer, and bracing connections are typically single bolt type with malleable iron washers.

Upper and lower walkways are existing along the conveyor support structure; the upper along the north side of the conveyor to the drive motor platform and the lower beneath the conveyor extending out to the load-out tower dock. The walkway along the south side of the conveyor no longer exists. Plank connection to stringers is typically by spikes.

The upper walkway consists of 4x12 flat cross planks spanning between 4x12 stringers spanning between the heavy timber caps. A two-rail guardrail is present along the outside edge without a kick plate. Guardrails are not present around the outside edges of the drive motor platform. The lower walkway consists of three 4x12 longitudinal planks spanning between the cross stringers. Single 4x8 cross stringers are present

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approximately midway between the bent double cross stringers and supported by the 4x12 struts. Guardrails are not present along the lower walkway.

The existing load-out tower is constructed of timber piling with heavy timber caps at the dock level, 10x10 columns extending from these caps up to heavy timber caps supporting the conveyor truss, and 4x8 bracing. The dock surface is 4x12 flat planks.

The existing pier head extends north and south of the load-out tower. Construction consists of timber piling with 12x12 caps, 4x12 stringers spanning between caps, and 4x12 cross planks perpendicular to the stringers. Fendering on the berthing side consists of timber fender piles at approximately 15 feet on center, upper wales, and timber batter piles from the upper wale level. A wale is also present on the inboard of the mooring side dock piles. Portions of the decks are missing.

Mooring dolphins are present beyond each end of the dock, four each to the north and south. We were unable to perform close observation of the dolphins; however, it was apparent from visual observation from the pier that several of the timber pile dolphins were deflecting under minor wave loading. This is an indication that some of the existing timber dolphin piles likely need repair or replacement.

All the timber piling and heavy timber caps are pressure-treated with creosote. The heavy timber columns and sawn lumber framing, bracing, and planking is typically untreated, though there are occasional uses of pressure-treated sawn lumber components.

The conveyor truss is constructed of various sizes of single-angle members. Trussed construction is used in both the vertical and horizontal directions, and connections are welded. The load-out cantilever is supported with 1 3/8-inch wire rope cable stays over an A-frame support at the top of the load-out tower and anchored to the timber piles below the heavy timber cap at bent 13.

Though a formal condition survey was not performed, general observations were made of the structures. Observations included:

- Structure-related piling appeared in good condition, except for a few instances of the fender piling which exhibit some top internal decay. Submerged portions are barnacle-encrusted.
- Heavy timber columns and sawn lumber bracing appear in good condition.
- Lower walkway and dock sawn lumber framing and walkway planks typically are in poor condition with considerable decay especially at fasteners.

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- Bolts are typically corroded, though the malleable iron washers are in better condition.
- Wales are typically in poor condition with various degrees of decay.
- Some of the dock batter piles are no longer attached at their top end to the dock structure.
- No surface indications of marine organisms were observed.
- The conveyor truss appears in good condition with only light corrosion evident.
- The mooring dolphins appear to require some pile replacement.

Structural work required to make the conveyor support, load-out tower, and dock structures safe and operable include:

- Remove damaged timber piling and replace with new steel pipe piling.
- Replace decayed lower walkway support framing and planks with new pressure-treated sawn lumber and add guardrails on each side of the walkway.
- Replace decayed dock deck support framing and decking with new pressure-treated sawn lumber and add guardrails on the non-mooring side of the dock.
- Replace decayed wales with new heavy timber wales.
- Replace corroded fasteners with new galvanized fasteners.
- Strengthen the existing upper north walkway guardrail as required and add an additional intermediate rail and a kick plate.
- Install a new guardrail along the edges of the drive motor platform.
- Install a new upper south walkway along the conveyor.
- Provide any construction and attachments required by the operation and current applicable codes.
- Supplement or replace the existing timber pile mooring dolphins with new steel pipe pile dolphins.

Response to FEIS Subtask 2.4.6: Dock Inspection, Study Questions 1-3.

The following are responses to the Study Questions based on our field investigation and assuming that repair of the existing structure would produce a safe and operable facility.

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Study Question 1. Approximately how many pilings would need to be replaced on the dock, fenders, and dolphins to make the dock capable of operating as proposed by the applicant?

We separated the overall structure into three main segments for discussion purposes. These segments are:

1. Main Conveyor Trestle
2. Pier
3. Mooring Dolphins

Each of these three segments has distinct purposes and, therefore, unique and different structural demands.

The *main conveyor trestle* is used to transport sand and gravel from the main pit operations to the load-out area at the pier and to provide access to the load-out pier situated in deeper water. Consequently, the live load demand on the trestle is relatively low with uniform live loads for the pedestrian access walkways and the material conveyor.

The *pier* is used to vertically support mechanical equipment for conveyor discharge onto barges, provide access for site personnel, and is lateral support for temporarily berthing barges. Loads on this structure are somewhat heavier and more complex in nature compared to the main trestle. Equipment loads are localized and are supported by dedicated vertical bearing piling, while lateral berthing loads are resisted almost entirely by the timber batter piles. The barge berthing loads on the pier are directly related to the size and weight of barges, berthing speed, various wind and wave conditions, and extent and capacity of the mooring dolphins.

The existing *mooring dolphins* consist of timber piles driven in clusters and "banded" at the top with several wraps of wire rope to form a large, single cantilever pile. These piles are typically driven around a center "king pile" that can be used as a mooring bollard for vessel mooring lines. Mooring dolphins of this type are common in Puget Sound. They are relatively flexible and resist lateral loads based on the collective bending strength of the grouping of timber piles. Lateral barge berthing loads imposed on the mooring dolphins are similar to those imposed on the pier. The lateral stiffness and capacity of the mooring dolphins needs to be adequate to protect the pier from potential damage due to barge berthing. These mooring dolphins are an important and integral part of the barge fendering and mooring system.

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Considering the required use of the various structures, future loading demand, and our on-site visual observation, we estimate that the total number of pilings requiring immediate replacement with steel pilings is as shown below.

Pile Summary

Structure	Pile Type	Total Number of Existing Piles	Estimated Number of Piles to be Replaced	Comments
Conveyor Trestle	Vertical	26	6	
Pier	Bearing	32	10	
	Batter	18	10	
Fender System	Fender	21	10	
Dolphins	Cluster	105	18	Replace select existing timber dolphins with steel batter pile dolphins (estimated 3 piles per dolphin).
Total		**202 piles**	**54 piles**	

Considering the relatively light live load demand on the conveyor trestle, recent pile repairs performed in the early 1990s, and the relatively good condition of the main supporting structure, we estimate that a minor amount of replacement piling will be required for the trestle. Similarly for the pier, replacement estimates for the bearing, batter, and fender piles are estimated at 10 each.

The existing timber dolphin pile clusters may be repaired by replacing certain existing timber piles with steel piles. Alternatively, all existing timber piling could remain in place and six additional steel batter pile dolphins (estimated three piles per dolphin) could be installed. These steel pipe pile dolphins would consist of a vertical fender pile with a pair of batter piles oriented shoreward at an angle to resist barge berthing and mooring loads. These steel dolphins are significantly stiffer than the existing timber cluster pile dolphins. Therefore, they significantly reduce the structural demand on the existing timber dolphins and improve the safety of the barge mooring system. We understand that the steel pile dolphins would only be placed in locations where there is no evidence of eelgrass.

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Study Question 2. Assuming relatively constant use, approximately how often would repairs need to be conducted and what would be the extent of those repairs?

The design life of typical timber marine structures in Puget Sound can range from 25 to 40 years. Based on our experience, there are many documented cases of timber docks in Puget Sound with life spans that have far exceeded this typical design life range. Treated wood used to be the material of choice for marine structures like the dock at Maury Island because of abundant material availability, relative ease of adapting construction to varying site conditions, and low initial cost. These structures were robustly designed and constructed of wood with a high retention of chemical preservative treatments (creosote). Historically, creosote preservative treatments have been effective at minimizing weathering and marine borer activity compared to other treatments.

The age of the Maury Island dock is 32 years. Correlating the existing condition of the timber piling to the estimated age of the dock can lead to an assessment of the expected remaining life span of the remaining pilings. Recommendations for timber piling replacement take into account, among other factors, expected pile vertical and lateral loading, extent of pile deterioration, degradation and damage, and cross-sectional loss due to fungal decay and/or marine borer activity.

Considering the expected loading and the condition of the existing piling based on our visual observation, we estimate that the existing pilings for the trestle and pier that do not require replacement at this time may have an expected remaining design life of 5 to 10 years. If the initial 36 piles that support the *trestle and pier* are replaced as recommended, then the remaining 61 existing trestle and pier piles could be replaced in subsequent maintenance and repair work within the approximate 5 to 10-year remaining design life. Three different repair and maintenance cycles could be employed, at 2 to 3-year intervals, with approximately 20 replacement piling per cycle to complete the replacement of the remaining pilings. (Depending on the berthing requirements and operating conditions of the pier, the existing 105 dolphin piles may not require further repair or replacement after installation of the steel pile dolphins.)

We would expect that annual maintenance of the timber superstructure would be performed on the pier and trestle to keep it functional and operating safely. Maintenance requiring "in-water" work such as pile repairs, pile wrapping, or other foundation maintenance is expected to be performed every 3 to 5 years, or more often as required, to repair unanticipated operational damage to the mooring system from barge berthing.

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Study Question 3. Over the long run, would replacement of the existing dock with a new, low-maintenance dock result in less in-water work?

The amount of "in-water" work for either initial dock replacement or initial repair with phased replacement of pilings is essentially the same. Some inefficiency due to multiple contractor mobilizations would obviously occur, but would not likely affect the amount of time the contractor would be executing the actual "in-water" work. Dock replacement would entail a significant amount of initial "in-water" work for demolition of the existing dock and construction of the new dock compared to performing maintenance and repair of the existing structure. The proposed approach to the Maury Island dock is to perform initial maintenance and repair for immediate use. Then, subsequent repair or phased replacement design would allow the pier and trestle pilings to be incrementally replaced in phases over time. Construction materials employed in the initial repair work would be selected to conform to an overall final pile replacement concept. For example, structural steel pipe piles would be used as pile replacement materials for the existing deteriorated timber bearing pilings.

Prestressed concrete, galvanized and coated structural steel, and certain types of plastics are typical materials used today for the design of waterfront structures. These materials are stronger and more durable than creosote-treated wood, resulting in increased pile capacities, structural spans, and other design efficiencies to reduce the number of piling or amount of time required for "in-water" construction work. Incremental replacement of timber piles with steel piling will result in reduced annual maintenance costs over the life span of the structure. However, because of the harsh and corrosive marine environment, exposure to wind, wave, tidal, and operating forces, all marine structures require some periodic and routine maintenance.

We hope this brief report and response to the Final Environmental Impact Statement Study Questions is adequate. Please call me if you or the King County have any questions regarding our evaluation.

Sincerely,

Reid Middleton, Inc.

David B. Swanson, P.E., S.E.
Director, Structural Engineering

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